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ABSTRACT

This study examined the relative impact of both student-driven and institutional factors on anticipated academic and career outcomes among first-year graduate students. The study addressed two primary questions: (1) whether significant gender and ethnic differences exist in the academic credentials, expectations, and degree of incorporation within graduate departments among first-year graduate students; and (2) which factors account for differences in expected academic and career outcomes. The study used data from a longitudinal study tracing the educational and career outcomes of the Fall 1995 entering cohort of 289 graduate students in engineering and the physical sciences. Findings indicated there were relatively few differences in the academic credentials, self-confidence, or expectations about their departments and faculty among the first-year students in these fields. There were significant differences in Anglo and minority student perceptions about the roles that gender and ethnicity play in academic outcomes. However, gender and race were not significant predictors of anticipated academic outcomes. International students expected higher grades, but anticipated lower earnings and more difficulty finding jobs than U.S. counterparts. Married students expected to finish earlier than non-married counterparts and anticipated higher wages upon degree completion. Two significant predictors for lower expected grade point averages were upper class status and student perception of race as liability. (Contains 64 references.) (CK)

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The Graduate Experience in Engineering and the Physical Sciences: Gender and Ethnic Differences in Initial Expectations and Departmental Incorporation

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The Graduate Experience in Engineering and the Physical Sciences: Gender and Ethnic Differences in Initial Expectations and Departmental Incorporation

INTRODUCTION

In 1994, 9,269 doctoral degrees were awarded in engineering and in the physical sciences of chemistry and physics. Approximately 56% of Ph.D. recipients in these disciplines were international students, 39.1% were Anglo,[1] 3.3% were Asian-American, .8% were Black and 1.3% Latino. If we exclude international women, only 7% of doctoral recipients were women (derived from data in National Science Foundation, 1995).[2] In order to address the underrepresentation of women and U.S. minorities in science and engineering, the Science and Engineering Equal Opportunity Act was enacted in 1980. While the number of women and minority students enrolled in postsecondary science and engineering programs has increased over the past 15 years, progress in achieving gender and racial equity is still elusive and continues to lag behind that achieved in other academic fields (Barber 1995; Lomperis 1990).

Although disparities in the participation of women and minority students have been documented for all stages of the scientific pipeline, Widnall (1988) and others (Adams 1993, Clewell & Ginorio 1996, Hurtado 1994, Nettles 1990) report that gender and ethnic differentials are exacerbated at the graduate level, *despite evidence that suggests that women and minorities enter graduate school with similar credentials* (Berg and Ferber 1983, National Science Foundation 1994). Relative to Anglo males, women and minority students are less confident in their abilities (Astin & Sax 1994, Berg & Ferber 1983, Felder, Felder, Mauney, Hamrin & Dietz 1995, Zappert and Stansbury 1984), less likely to complete graduate degrees (Adams 1993, Hall, Mays & Allen, 1984, Schroeder & Mynatt 1993, Zwick 1991), take longer to complete their degrees (Baird 1990, Bowen and Rudenstine 1992, Sotelo Viernes, Turner & Thompson 1993, Stricker 1994, Vetter 1996), and are more likely to terminate their graduate studies at the master's level (Hollenshead, Wenzel, Lazarus & Nair 1996, Schroeder & Mynatt 1993, Widnall 1988). Further, the existing evidence suggests that the quality of the graduate experience varies considerably across gender and ethnic lines (Adams & Conley 1986, Blackwell 1989, Hurtado 1994, Long 1990, Malcom 1992, Nettles 1990, Perrucci 1984,

Richardson 1989, Smith & Davidson 1992, Sotelo Viernes, Turner & Thompson 1993). These disparities are accentuated within the professions where relatively few women and minorities hold top positions in engineering and science, earn less than Anglo men at every level, have higher levels of unemployment, and encounter fewer opportunities for advancement (Benditt 1992, Jagacinski & Lebold 1985, National Science Foundation 1994, Vetter 1996).

Previous studies have tended to emphasize "student-driven or individual-level" factors in explanations for these discrepancies in academic and career outcomes (e.g., Felder et al. 1995, Garcia, Yu & Coppola 1993, Hackett, Betz, Casas & Rocha-Singh 1992, Jagacinski & LeBold 1981,1985, Lent, Brown & Larkin 1984, 1986). Questions addressed in these analyses have focused on assessing the extent to which gender and ethnic differences in student attributes and expectations contribute to these differential academic and career outcomes. As a result, recent studies have focused on the influence of institutional or structural barriers to achieving these outcomes. To address this concern, the work of Astin and Astin (1992), Girves and Wemmerus (1988), Nettles (1990), Tinto (1993) and others (i.e., Adams 1993, Baird 1990, Cook & Swanson 1978, Hurtado 1994, Hurtado and Carter 1994, Pascarella & Terrenzini 1979, Sandler & Hall 1986, Stricker 1994, Widnall 1988) underscores the significance of "environmental or institutional" factors as predictors these outcomes. In this aforementioned body of work, emphasis shifted to examining the impact of institutional or discipline-driven factors, such as climate, type and size of program, faculty/student interactions, advising and mentoring, type of financial support, and participation in research clusters on academic persistence, time to degree, achievement and movement into professional careers.

In this study, we examine the relative impact of both student-driven and institutional factors on patterns of initial departmental incorporation as well as anticipated academic and career outcomes among first-year graduate students in engineering and the physical sciences. Two primary questions are addressed: (1) Are there significant gender and ethnic differences in the academic credentials, expectations, and degree of incorporation within graduate departments among first-year graduate students? and (2) What factors account for differences in expected academic and career outcomes?

To address these questions, data from the first wave of the Graduate Experience Project collected for the Fall 1995 cohort of graduate students entering engineering and the physical sciences at a major research university are utilized.[3] Given on-going concerns about the financial, educational and occupational costs associated with the 40-50% attrition rates among graduate students (Bowen & Rudenstine 1992), this study represents a preliminary step in the development of an explanatory model for graduate student persistence and performance in engineering and the physical sciences.

FACTORS SHAPING THE GRADUATE EXPERIENCE

Although numerous studies have examined the aspirations, choice of academic majors, levels of achievement, retention, progress towards degree, and career outcomes of undergraduate students (e.g., Astin & Astin 1992, Astin & Sax 1994, Bean 1980, Hackett et al. 1992, Jackson, Gardner & Sullivan 1993, Jagacinski & LeBold 1981, Lent et al. 1984, 1986, Oakes 1990, Pascarella, Smart & Nettles 1987, Tinto 1993, Ware & Lee 1988), there is a paucity of research on these issues for graduate students, particularly for those in engineering and the physical sciences (Girves & Wemmerus 1988, Hollenshead et al. 1996, Tinto 1993). According to Tinto (1993:231), what is particularly distressing is not the lack of research on graduate students, but rather, the lack of a "comprehensive model or theory of graduate persistence or use of the methodological strategies that have been successfully employed in the study of undergraduate persistence."

In order to address these shortcomings, Tinto (1993:231) proposes a status attainment model that recognizes the importance of "personal and intellectual interactions that occur within and between students and faculty and the various communities that make up the academic and social systems of the institution." To accomplish this, Tinto (1993) and others (Girves & Wemmerus 1988, Nettles 1990) argue that it is necessary to situate the study of graduate persistence within the context of the departments and disciplines within which these interactions occur. The findings of Nerad (1990) and Zwick (1991) suggest considerable differences in graduate persistence within institutions and across disciplines underscore the need for inclusion of discipline-specific measures.

Moreover, graduate persistence is shaped by the degree of academic integration within one's department and larger discipline (Girves & Wemmerus 1988, Tinto 1993). Of particular importance are the relationships formed between students and departmental faculty in general, the research adviser or mentor in particular, and among others within the larger disciplinary community (Berg & Ferber 1983, Blackwell 1989, Frierson, Hargrove & Lewis 1994, Golde 1994, Hollenshead et al. 1996, Smith & Davidson 1992). Student perceptions of faculty in terms of treatment as a junior colleague, the quality of advisors and mentors, and support are considered critical factors shaping decisions to persist in graduate school. Students who feel that faculty are supportive, express satisfaction with their mentors, and are engaged in collaborative research activities with faculty are more likely to complete their degree requirements (Berg & Ferber 1983, Hurtado and Carter 1994). Moreover, students who are able to incorporate the prevailing norms which frame the discipline are more likely to make a successful transition to careers in their fields of study (Tinto 1993).

However, graduate students also must cope within external communities such as family and work (Tinto 1993:233-234). The ability to juggle multiple and often, conflicting roles between school, work, and family is seen as a critical factor in persistence. Students who are either unable or unwilling to cope with the competing demands on time and energy may become disconnected from the intellectual life of the department if external community demands prevail. On the other hand, students immersed in the intellectual community, may feel isolated from the rest of the "real world."

Tinto (1993:235-237) proceeds to develop a dynamic model of graduate persistence focusing on three critical points in the doctoral process: (1) the stage of transition occurring within the first year of study, (2) the development of competence stage when students complete the requirements for candidacy, and (3) the research stage leading to the completion of the degree. In the first stage, persistence is shaped by the development of academic and social relationships within the department as well as the level of individual commitment towards degree completion. During the pre-candidacy stage, the development of departmentally recognized competencies are critical to persistence. It is not only the acquisition of knowledge that is important, rather, it is the recognition by faculty and student

peers of individual competency that shapes perceptions of academic competency. The final stage of persistence is characterized by the increasingly important role of individual mentors and advisors in the professional socialization and subsequent early career attainment of the candidate. Throughout the process, Tinto (1993:237) suggests that the level and type of financial support indirectly affect persistence, although he hypothesizes that the effects are dynamic as well. In order to test his theoretical model, Tinto (1993:239-241) proposes a dynamic model that allows for the inclusion of different sets of factors to account for persistence during each of the three time periods. Moreover, the model allows for time-varying co-variates to capture changes in the relative importance of his predictors.

Although the conceptual model proposed by Tinto (1993) offers promise for a more comprehensive understanding of graduate persistence, it has yet to be tested across a range of institutional programs or disciplines, mainly because there are few longitudinal datasets which capture the process. Questions that need to be addressed focus on how and when longitudinal data should be collected as well as what methodological approaches (even among the event history methods) are the most appropriate. Further, possible interactions between individual-level and institutional-level factors have not been fully explored either theoretically or empirically. Moreover, the model like previous studies, focuses on a general model of doctoral persistence, thus failing to address both possible degree-and -field-specific influences on student persistence and performance (Brush 1991, Hornig 1987, Malcom 1992, Pyke & Sheridan 1993). In addition, while researchers acknowledge the importance of ethnic status on graduate student persistence, both as independent influences and in interaction with gender (Clewell & Ginorio 1996, Malcom 1992, Nettles 1990), the model provides only tangential suggestions as to how gender and ethnicity might affect anticipated outcomes. Finally, with the implied emphasis on quantitative methods and measures, to what extent does the Tinto model fail to capture the broad range of experiences shaping graduate careers (Golde 1994).

We propose to test a conceptual model that builds upon Tinto's (1993) model of doctoral persistence that also incorporates theoretical assumptions developed by Girves and Wemmerus (1988)

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Nettles (1990), and Hurtado and Carter (1994) to examine how student characteristics, departmental incorporation (which is similar to Tinto's concept of academic integration), and expectations about faculty/student interactions impact the academic and career expectations of first-year graduate students in science and engineering. A unique feature of this analysis is that we capture this information at the onset of the graduate career, thereby providing a basis for comparison as we trace the academic and professional careers of master's level and doctoral students in these fields.

METHODS

Data and Sample

This study uses data from the first wave of the Graduate Experience Project, a longitudinal study that will trace the educational and career outcomes of the Fall 1995 entering cohort of graduate students in 19 departments or programs in engineering and the physical sciences (chemistry, physics) at a major research university in the Midwest (N = 590). Approximately 20% of the students are female and 41% percent of the students are international students. In Fall 1995, 88% of the students were enrolled in the College of Engineering. Approximately 30% of the students were enrolled in Ph.D. programs. The average undergraduate GPA for the cohort was 3.5 (4.0 scale) and the average GRE quantitative score was 743 (see description in Appendix A).

At the onset of the Fall 1995 semester, all first-year graduate students in the participating departments and programs were sent a mail-back questionnaire that included items regarding undergraduate preparation, post-BA work experience and training and a series of modules regarding respondent expectations about their interactions with faculty and students in their programs as well as anticipated educational outcomes.[4] A total of 289 students -- 49% of the entire cohort -- responded to the survey. The characteristics of the sample cohort differ somewhat from the entire cohort with a higher fraction of female respondents (25%), and a slightly lower fraction of students from the College of Engineering (83%). Approximately 13% of the sample respondents had U.S. minority status and another 36% of the sample was comprised of international students. Slightly less than one-third of the respondents were enrolled in Ph.D. programs in the Fall 1995 semester. The

average undergraduate GPA was 3.5 and the average GRE quantitative score was 740. Since data collection efforts occurred during the period between September 1995 and January 1996, we have also examined differences in patterns of response between early and later respondents. On all but two key items, responses were similar across these two groups of respondents. The two groups differed significantly in reported membership in a research group and respondent expectations regarding finding a job in their field of study. Later respondents were more likely to report being incorporated into a research group and less likely to expect to find a job in their field. These differences may reflect changes that occurred as a result of being on campus for approximately one semester.

Model Specification

In this study, we hypothesize that student expectations regarding academic and career outcomes are influenced by five sets of factors: the demographic characteristics of the respondent; the social origins of the respondent as measured by parental educational, occupational and class attributes; undergraduate preparation and post-BA training and work experience; respondent expectations and perceptions about the academic environment in graduate school; and institutional factors that shape the existing academic environment. We incorporate theoretical constructs developed within the academic persistence and time to degree literature (see Felder et al. 1995, Girves & Wemmerus 1988, Pascarella & Terenzini 1979, Stricker 1994, and Tinto 1993) to develop a model to predict the academic and career aspirations of first-year graduate students.

Previous studies suggest that there are significant differences in graduate student outcomes along gender and racial lines (Clewell & Ginorio 1996, Felder et al. 1994, Hackett et al. 1992, Hollenshead et al. 1996, Widnall 1988). Based on these studies, we anticipate that women and minority students will have lower expectations about grades, will expect to leave school after earning the master's degree, and expect to take longer to complete their degree than their Anglo male counterparts. Further, we hypothesize that women and minority students anticipate earning less upon completion of the degree and have more ambivalent expectations about finding jobs in their chosen field.[5] In contrast, because of higher selectivity in the admission of international students, we

hypothesize that foreign students expect higher grades, expect to complete doctoral studies, and anticipate finishing their degrees faster than U.S.-born students. Since their frame of reference is their country of origin, we also hypothesize that foreign students expect lower wages upon completion of their degrees and anticipate having more difficulty finding a job in their field of study.

Given Tinto's (1993) discussion of the potential conflicts between the academic community and the external communities of family and work, we expect that being married or employed has a negative effect on academic performance, by lowering expectations about grades, lowering the odds of pursuing a doctorate, and increasing the time to degree because of additional family and work responsibilities. In addition, we expect that married or working students have lower expectations about finding a job in their field of study because these competing responsibilities limit access to campus-based job and information networks.

The social origins of the respondent, represented by parental attributes, are expected to exert a positive effect on anticipated academic and career outcomes. Students whose parents have college degrees, who have parents that are employed as scientists or engineers, and who come from more affluent social class backgrounds are expected to have higher expectations about grades, higher degree and career aspirations, expect to earn more and find related jobs upon completion of their degree (see Astin & Sax 1994, Jagacinski et al,. 1983, 1987, Ware & Lee 1988).

Respondent undergraduate and post-BA experience are expected to positively impact academic and career outcomes (Girves & Wemmerus 1988). Students who feel they are better prepared, have higher levels of academic ability as measured through their undergraduate grades, or have high levels of academic self-confidence are hypothesized to have higher expectations about grades, higher degree aspirations, and plan to finish their degrees more quickly than students who feel less prepared (Lent et al., 1986, Ware et al. 1985). Students who already have a master's degree or post-BA work experience in their field are also expected to earn higher grades and complete the doctorate. They may, however, anticipate a longer time frame to complete the degree since their experiences may have given them more realistic time frameworks within which to cast their academic plans. Further, these

students would be more likely to anticipate finding a job in their field and earning higher wages upon completion of degree because of their additional credentials or work experience.

Student expectations about their degree programs, faculty and fellow students are also expect ed to shape the anticipated outcomes of first-year graduate students (Felder et al. 1995, Hackett et al. 1992). Students who hold more positive attitudes about faculty/student interactions are more likely to anticipate higher grades and aspire to obtain the doctorate because they anticipate opportunities to work with faculty (Hurtado and Carter 1994, Nettles 1990, Tinto 1993). In addition, they would anticipate completing their degrees in less time than students with less positive attitudes. Moreover, we hypothesize that students who perceive that their gender or racial status are liabilities, will expect to earn lower grades and be less likely to believe they can complete the doctorate or perhaps finish their current degree. We argue that students who already feel that they are at a disadvantage relative to other students may internalize these negative attitudes and beliefs and hamper their progress within their academic programs (Nettles 1990). Further, these attitudes may become manifest in the academic environment as part of what has been termed the "chilly" climate (Hurtado 1994, Hurtado and Carter 1994, Richardson 1989, Sandler & Hall 1986). However, individuals holding more positive attitudes about themselves are expected to anticipate finding jobs in their field and earning higher wages. However, it may be possible that women who believe that their admission to graduate school was mitigated by their status as women (thereby gender is identified as an asset) may be made to feel uncomfortable in their academic programs as male faculty and staff make suggestions that their presence within the academy was not based on academic merit (Golde 1994, Vetter 1996).

Finally, we hypothesize that academic performance as well as career expectations are conditioned by a number of institutional factors. Type of degree and program are expected to impact student expectations about grades, degree aspirations, and expected time to degree (Baird 1990, Stricker 1994). They are also expected to positively affect anticipated earnings and future job expectations. In addition, students who have become integrated into a research group or who already have a mentor are expected to anticipate more positive academic and career outcomes (Astin and Sax

1995, Richardson 1989). Conversely, students who have concerns about their funding are more likely to expect lower grades, may not aspire to further graduate training, may be worried about completing the current degree, and may take longer to complete the degree (Tinto 1993). Also, these students may expect lower wages and more difficulty in finding jobs in their field of study since financial constraints may not allow them to prolong the job search process (Hollenshead et al. 1996, Vetter 1996).

Outcome Measures

Three anticipated academic outcomes were used in this study: expected 95-96 grade average, highest degree aspirations (Ph.D.), and anticipated time to degree. Expected 95-96 grade average was estimated using respondent self-report of the grades they anticipated receiving during the 1995-96 academic year. Degree aspiration was measured using responses to a survey item asking the respondent to identify the highest degree they expect to obtain. One dummy variable indicating expected completion of the doctorate was derived from their responses. Anticipated time to degree was measured using responses to a survey item asking respondents to identify how many years they estimated it would take to complete their current degree program.

In addition, two anticipated career outcomes were also examined: expected annual wages upon completion of degree and respondent expectations about finding a job in their current field of study. Expected annual wage was estimated from a survey item asking respondents to indicate in U.S. dollars what they expected to earn after completing their current degree program. Respondent expectations about finding a job in their current field of study was measured as a dichotomous variable where 1 indicates an affirmative response.

Predictor Measures

Demographic characteristics. Five demographic attributes based on respondent self-reports were used: gender, minority status, resident status, current marital status and employment status during the 1995-96 academic year. Gender was coded as a dummy variable with 1 indicating the respondent was female. Minority status was derived from responses to three items on the survey:

place of birth, racial identification and Hispanic origin identification. Respondents were coded as being of minority status if they were U.S. native-born and identified themselves as being of Black, American Indian, or Asian racial heritage, or indicated they were of Hispanic origin. Resident status was derived from two questions on the survey: place of birth and residency status for enrollment purposes. Respondents who indicated that they were foreign-born and were considered international students were coded as being foreign students (code = 1). All other students were given a code of 0. The result of this process was the creation of six mutually exclusive groups: Anglo males and females, U.S. minority males and females, and foreign males and females. Since the number of U.S. minority students is relatively small, the dummy variables described above were used in the multivariate models. Current marital status was collapsed into a dummy variable indicating if the respondent was currently married or living with a partner. Employment status was measured using respondent self-reports of on-campus or off-campus employment. Respondents indicating they would work as a GA, TA, RA or other on-campus employment as well as respondents indicating they would work full or part time off-campus were coded as being employed.

Background characteristics. Seven dummy variables were constructed to account for differences in the social origins of the respondents. These include the educational attainment of mother and father, indicators identifying whether the respondent's parents were employed as scientists or engineers, two indicators of relative social class position, and an indicator of mother's employment status. Parental educational attainment was measured in terms of two dummy variables indicating whether the respondent's mother and father completed college degrees. The reference category were parents without college degrees. Occupational status was measured in terms of employment as a scientist or engineer. Parental occupations were classified using the 1990 Occupational Classificational System of the Bureau of Labor Statistics. Occupations in the engineering or scientist categories were coded as 1, all other occupations were coded as 0. Two measures indicating the relative social class of the respondent were derived from self-reports of class. The high fraction of international students in the sample prevents our use of U.S. income categories as an adequate measure of economic class

standing. Two dummy variables representing lower/working class origins and upper class origins were constructed. The reference category was the middle class. Finally, a dummy variable indicating whether the respondent's mother was employed was also included. Previous studies suggest that maternal employment increases the likelihood that women would enter male-dominated fields (Jagacinski et al 1983, 1987). These measures are summarized and presented in Appendix B.

Undergraduate/Post BA preparation. Previous academic achievement was measured in terms of undergraduate grade point average, respondent self-rating of undergraduate preparations, completion of the Master's degree, post-BA work experience in current field of study, and student self-ratings of academic ability. Undergraduate grade point average was based on student self-reports of overall cumulative grade point average at time of completion of degree. Undergraduate preparation was measured by an item that asked respondents to respond to the question, "how well do you think that your undergraduate education has prepared you for your graduate program?" Respondents that indicated "very well" were coded as 1, 0 otherwise.

Completion of the master's degree was derived from a series of items asking respondents to identify any post-BA training. Students indicating they had completed the master's degree were coded as 1. Post-BA work experience was measured as a dummy variable response to the question, "Since completing your undergraduate degree, have you been employed in a job or jobs related to your proposed field of graduate study?" This work experience included paid employment, internships, cooperative work experience opportunities, and any volunteer experience in field. All respondents who indicated that they had completed one of these kinds of employment were coded as 1, 0 otherwise.

Academic self-confidence was measured using a modified version of the Cooperative Institutional Research Program (CIRP) scale which asks students to rate their academic abilities relative to the abilities of their peers (see Astin & Sax 1995). Respondents were asked to rate themselves relative to other students entering graduate school in their fields of study in terms of general academic ability, analytical and critical thinking skills, knowledge of field, oral and written communication skills in English, language skills other than English, mathematical and computer skills, and research skills.

In addition, they were asked to rate themselves in terms of their drive to achieve, leadership, competitiveness, ability to work independently and cooperatively, listening ability, and their intellectual and social self-confidence. For each item, students rated themselves on a scale from 1 to 5 with 1 indicating ability in the top 10% and 5 indicating ability in the bottom 10%). Overall scores ranged from a low of 0, indicating a self-rating of ability in the lowest 10% of their peers on all items to a high of 190, indicating a self-rating of ability in the highest 10% of their peers on all items.

Student expectations. Three measures of student expectations were used in the study: student ratings of faculty, and student perceptions of gender and race as a liability. Student ratings of department faculty were based on answers to a 15-item semantic differential scale which rated faculty in terms of their expertise in teaching and research, advisement, accessibility to students, cooperation, openness, impartiality, approachability, interest in students, and willingness to share experiences and provide opportunities for professional development. For each set of paired traits (i.e. accessible *vs.* inaccessible) students were asked to rate faculty on a scale from 1 to 7. Overall scores could range from a low of 90 to a high of 120. Higher scores indicate that respondents had more positive expectations about department faculty.[6]

Two additional expectation measures were utilized to examine the extent to which student perceive race or gender as assets or liabilities to academic achievement. Each respondent was asked to complete a 17-item scale adapted from Astin and Sax (1995) that asks students to respond to the question: "How do you think each of the following affected your admission to graduate school? Items included statuses such as gender and race, to items about the reputation of their undergraduate institution and previous work experience. For each item, respondents were asked to identify whether each item was an asset, liability, or had no effect. If respondents indicated an asset or a liability, they were asked to indicate why a particular item was beneficial or detrimental to their admission to graduate school. In our analyses, we incorporated two dummy variables indicating that gender and race were considered to be liabilities.

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Institutional factors. Two measures were included to control for variations in program duration and requirements: the type of degree program in which student was enrolled, the specific program in which the student was enrolled. The type of degree program was measured using a dummy variable to indicate whether the student was in a master's program (code = 0) or in a doctoral program (code = 1). The program in which the student was enrolled was based on a question asking students to identify the department of current enrollment. Since the sample sizes were quite small in a number of departments, a dummy variable was constructed to indicate whether students were enrolled in the physical sciences (code = 1) or engineering (code = 1).

In addition, three measures, including affiliation with a mentor, membership in a research group, and financial support were used to examine the degree of initial institutional support. Affiliation with a departmental mentor was measured using respondent reports of having a mentor prior to the onset of Fall 1995 courses. Likewise, incorporation into an existing research group was measured using responses to an item asking if students already belonged to a research group within their department. Finally, the degree of institutional financial support was measured using a dummy variable indicating whether respondents had some or major concerns regarding their ability to finance their graduate training.[7]

Five models are estimated for each of the outcome variables. Model 1 focuses on the effects of demographic characteristics on expected GPAs, highest degree aspirations, time to degree, anticipated annual earnings at completion of degree, and expectations to find a job in their field of study. Model 2 introduces controls for differences in the social origins of the respondents. In Model 3, undergraduate and post-BA preparation variables are included to control for differences in academic ability, training, and related work experience. Model 4 incorporates student expectation variables to examine how student perceptions affect anticipated academic and career outcomes. Finally, a set of control variables for differences in programs and initial incorporation within the graduate department are introduced in Model 5. The models are estimated hierarchically, permitting an assessment of changes in the coefficients when additional sets of influencing factors are controlled. The full set of

models is estimated for the pooled sample since sample sizes for women and minority student populations are quite small.

RESULTS

Characteristics of First Year Graduate Students in Engineering and the Physical Sciences

Are there significant differences in the characteristics of students at time of entry into graduate school that might shape different sets of expectations between men and women; between Anglo, minority and international students? Given the results of our analyses, our answer would be no. As shown in Table 1, with the exception of lower GRE verbal scores for international students which are anticipated, and lower GRE quantitative scores for women (720 *vs.* 754),[8] there are relatively few differences in the academic credentials of first year students in engineering and the physical sciences. On average, students entered their graduate programs after performing above average work (3.5 GPA) at the undergraduate level. Moreover, a sizable fraction of the respondents felt that their undergraduate training prepared them very well for graduate school (32% women, 42% men). Moreover, both men and women, regardless of race, felt fairly confident in their academic abilities. In addition, all groups had similar expectations about the academic environment they would be entering.

---Table 1 about here---

Further, there were similar patterns of post-BA training and work experience across all groups. One in nine women and one in eight men had already completed master's degrees, although these fractions were higher for international students. Moreover, 56% of the men and 62% of the women indicated that they had field-relevant work experience since completing their undergraduate degrees.

Are initial expectations different across gender and racial lines? The results presented in Table 1 also suggest that there are few differences in student expectations about their departments, anticipated interactions with faculty, and anticipated relations with fellow graduate students. However, there are significant differences in Anglo and minority student perceptions about the roles that gender and ethnicity play in academic outcomes. Approximately 41% of the women indicated

that being a woman was an asset while less than 2% of the men thought that their status as men was advantageous. Of interest, these positive perceptions about gender were particularly strong for Anglo women. In contrast, while none of the women thought that their gender was a liability, 8% of the men did with about 12% of Anglo and minority men indicating that being a male put them at a disadvantage.

When perceptions about the impact of race and ethnic status were examined, we found that relatively few men and women, with the exception of minority students, indicated that their race or ethnicity was an asset. Moreover, while none of the women felt that their race or ethnic status was a liability, 12% of Anglo men and 22% of minority men indicated that this status was detrimental. While it is clear that the majority of students feel that these statuses had no impact at all on their admission to graduate school nor do they feel their academic careers will be affected, these findings warrant further assessment since they may be indicative of conditions that lend themselves to the development of hostile academic environments.

If first year students share similar characteristics and expectations, is it possible that there may be differences in the manner in which they are incorporated into their departments that may later affect academic outcomes? As a way of attempting to examine patterns of initial incorporation, we examined the extent of non-admissions related contact with the department prior to the onset of the academic year, the extent to which students were involved with research advisors and mentors, and incorporation within research groups. Moreover, we examined the extent to which students were supported financially by their departments. The results of these analyses are presented in the bottom panel of Table 1. With the exception of more departmental contact for Anglo men relative to foreign men, the gender and racial differences in these measures of institutional incorporation were statistically insignificant.

Since institutional incorporation, particularly with mentors and within research groups, is considered vital to the academic and career development of students, we examined a set of factors in two logistic regression models to assess what factors increased the odds of membership in a

research group or having a mentor in the first year of graduate study. The results are presented in Table 2. Membership within a research group or having a mentor were strongly linked to the kind of financial support received by the department. The odds of being a member of a research group were 25 times higher for students who had graduate fellowships. In addition, the odds of having a mentor were 12 times higher for students who had graduate assistantships. The next strongest predictor of having a mentor or being a member of a research group was if the student had interactions with the potential mentor/advisor prior to the beginning of the academic year. The odds of having a mentor were 9 times higher for students who had these prior contacts; the odds of being a member of a research group were 13 times higher for students having these contacts. In addition, two demographic variables, foreign status and employment status were significant predictors of membership in research groups. The odds of belonging to a research group were 8 times higher for students who indicated that they would be employed during the 1995-96 academic year. Also, foreign students had 4.5 times higher odds of belonging to a research group relative to their U.S. counterparts.

---Table 2 about here---

Anticipated Academic and Career Outcomes

Previous studies suggest that the differential patterns of academic achievement for women and minority graduate students relative to men may reflect differences in initial expectations. We explore this more fully in Table 3. As we can see, except for significant differences in expected GPAs for the 1995-96 academic year, there are no other statistically significant differences across gender and racial lines. Consistent with previous studies (e.g., Berg and Ferber 1983, Hackett et al. 1992), men expect to have higher grades than women (3.8 *vs.* 3.7 GPA). Also, foreign men and women expect to have higher grades (3.9 GPA) than Anglo women (3.7). Approximately 58% of the women and 63% of the men expect to attain doctoral degrees. Both men and women expect, perhaps unrealistically, to complete their degrees in three years.[9] With the exception of foreign students, who tend estimate annual salaries that are lower than their U.S. counterparts, respondents expected to earn salaries in the mid-$40s to $50,000 range.[10] Approximately 59% of men and women expect to find jobs in

their current field of study. Again, this fraction is lower for international students who may be anticipating difficulties in findings jobs in their countries of origin.

---Table 3 about here---

Predicting Anticipated Academic Outcomes of First Year Graduate Students

Hierarchical OLS regression was used in the equations predicting expected first year academic achievement and anticipated time to degree. In the OLS equations reported in this paper, metric indicators of GPA and time to degree were used instead of using the logarithmic transformation of these measures.[11] A hierarchical logistic regression model was used to predict highest degree aspirations. In all of the following discussion of logistic regression results, the antilogs of the logistic regression coefficients are used. The antilog is interpreted as the unit change in the odds of Y occurring given a unit change in X.[12] Also, unless coefficient changes across models are significant, we report the findings from the full specification model (Model 5). The results of these analyses are presented in Tables 4 through 6 and are summarized below.

One of the key findings across these models is that gender and race are not significant predictors of anticipated academic outcomes once we control for differences in social origins, undergraduate and post-BA preparation, student expectations, and institutional factors. On the other hand, several institutional factors are significant predictors of expected academic outcomes. This suggests that first year students in engineering and the physical sciences entered their graduate programs with similar academic credentials and expectations. In this highly selective group of graduate programs, if differences emerge in the patterns of academic expectations over the course of their graduate careers, it seems very likely that the differences are products of institutional factors. We will return to this observation later.

---Table 4 about here---

Expected GPA. The OLS regression results for the models predicting expected GPAs are presented in Table 4. Once we control for differences in the background characteristics of students, their undergraduate and post-BA experience, student expectations and institutional factors, the most

significant predictor of expected GPA is foreign status. International students expect GPAs that are approximately .3 point higher than U.S. students. As anticipated, prior academic ability is a significant predictor of expected academic achievement. The second strongest predictor of expected GPA is undergraduate GPA. For each point increase in undergraduate GPA, we would expect a .2 point higher expected GPA. Further, two additional measures of prior academic ability were significant: self-ratings of academic ability and undergraduate preparation. Each 25-point increase in the academic ability rating was associated with a .1 point higher expected GPA. Also, students who felt very well prepared for graduate school expected GPAs that were .1 point higher relative to those who felt less prepared. Finally, students enrolled in the College of Engineering expected GPAs that were nearly .2 point higher than their counterparts in the physical sciences. We suspect that this may reflect differences in expectations about grading across the programs.

What accounts for lower expected GPAs? Two factors emerged as significant predictors: upper class status and student perception of race as a liability. Students from upper class backgrounds expect GPAs that are .2 point lower than their middle class counterparts, which may reflect class differences in expectations about grading. More disturbing is the association between student perceptions about racial status and expected grades. Students who felt that their racial status was a liability (these are all U.S. men) expected GPAs nearly .2 point lower than students who felt that race either had no effect or was an asset. What we are not able to ascertain at this point is whether students expect that their grades will be lower because of their racial status (i.e. discrimination).

---Table 5 about here---

Degree aspirations. The most significant predictor of aspiring to obtain a doctoral degree, our measure in this equation, is the current degree program in which the student in enrolled. As might be expected, the odds of expecting to obtain the doctorate are approximately 4 times higher for students enrolled in Ph.D. programs. Also consistent with previous findings, students whose fathers are scientists or engineers have 3.3 times higher odds of expecting to obtain a doctorate. The third most significant predictor of degree aspirations was belonging to a research group. The odds of expecting

to obtain a Ph.D. are 2.6 times higher for students already incorporated into research groups. This would suggest the need to involve students in these groups at the earliest stage of their academic careers. Previous work experience in the field of study also increased degree aspirations. Students with post-BA work experience have odds of expecting to obtain the Ph.D. that are 2 times higher relative to those of their counterparts without related experience. Finally, more positive student expectations about faculty/student interactions were also significant predictors of degree aspirations. For each additional point increase in the faculty interaction score, which indicates more positive expectations, the odds of expecting to obtain a doctorate increase by 8%.

Two factors were found to significantly reduce degree aspirations: mother's employment outside of the home and self-rating of undergraduate preparation. In contrast to previous studies reporting a positive relationship between mother's employment and degree aspirations, we found that students who have mothers employed outside the home have 55% lower odds of expecting to obtain the doctorate. We are not quite sure what may be driving this result although we speculate that this may reflect expectations that are tempered by information about employment opportunities and work environments that are provided by their mothers. Also somewhat counterintuitive, is our finding that students who felt they were well prepared for graduate school have 54% lower odds of expecting to obtain a doctoral degree. This may reflect variations in the way in which students envisioned and defined their undergraduate preparation.

---Table 6 about here---

Anticipated time to degree. Among the most significant predictors of anticipated time to degree are institutional factors, suggesting that time to degree is affected by how degree programs and requirements are structured within departments. Students enrolled in Ph.D. programs expect it will take a year longer to complete their degrees than master's level students. Moreover, students enrolled in the College of Engineering expect that it will take 8 months less to complete their degrees. Of interest, students who indicate that they have mentors expect to complete their degrees 5 months later than those without mentors. This may reflect expectations about the need for more time to

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engage in collaborative work between students and their mentors.

What other factors increase expected time to degree? Students who have higher undergraduate GPAs expect to be in school longer. Each additional point increase in undergraduate GPA is associated with a 7 month increase in anticipated time to degree. It may be that these students high ability students are aspiring to obtain doctoral degrees. Students whose fathers are scientists or engineers expect to finish their degrees 5.5 months later, perhaps suggesting that fathers may provide specific information about skills needed to work in these fields or simply a more realistic timetable that is required to attain these skills. Also, students who perceive of their gender as a liability (again, these are males) expect to complete their degrees 7 months later than their counterparts who believe than gender is an asset or has no effect on their academic status.

Three additional factors reduce anticipated time to degree: prior completion of a master's degree, student's marital status, and father's educational attainment. As might be expected, students who already hold a master's degree expect to finish their current degree programs 4.5 months earlier. Students who are currently married or whose fathers have college degrees expect to finish about 4 months earlier. Both married students as well as students with college-educated fathers may feel some pressure to complete their graduate training as quickly as possible.

Predicting Anticipated Career Outcomes of First Year Graduate Students

In this section of the paper, the results of our regression equations predicting two anticipated career outcomes, expected annual wages upon completion of degree and expectations about finding a job in the field of study, are presented. Hierarchical OLS regression was used in the wage equation and logistic regression was used to predict expected job outcomes. Results are summarized in Tables 7 and 8. As was noted from our earlier models predicting academic outcomes, our results suggest that gender and minority status also are insignificant predictors of anticipated career outcomes. Again, there are several institutional factors that are significant and warrant further investigation.

---Table 7 about here---

Expected annual earnings upon completion of degree. The most significant predictors of anticipated earnings are the two measures indicating student perceptions of their gender and race status as liabilities. However, these measures produce opposite effects. Students who perceive of their gender as a liability (these are U.S. men) expect to earn $9,211 less, after controlling for differences in demographic characteristics, social origins, previous training and work experience and institutional factors. However, of interest, men who indicated that their race was a liability (while these include both Anglo and minority men), expect to earn $8955 more. Although we need to explore this relationship more fully, we tentatively suggest the following. It is very likely that this measure may be picking up some effects of gender and race, albeit indirectly, because these are attitudinal measures about how these statuses impact particular outcomes and not direct effects attributable to gender and racial status. The men who are most likely to feel disadvantaged at this point are Anglo males. While they may feel disadvantaged relative to women or to racial minorities, that still may not totally depress anticipated annual earnings. As we saw from the descriptive statistics, Anglo men had the highest average expected earnings. Thus, they may expect higher earnings, but may feel that their ability to achieve these higher earnings are compromised by their status as Anglo men. These mixed expectations about gender and racial status may also be mitigated by student expectations about faculty/student interactions. Students who have more positive expectations about faculty/student interactions expect to earn $381 more for each point increase in the faculty/student interaction rating scale.

Of interest, none of the undergraduate and post-BA training and experience measures were significant predictors of anticipated earnings. It may that students in graduate school feel that their future earnings and job opportunities are linked to their graduate school training and work experience. While these results are intuitive, it was surprising that possessing the additional credential of a master's degree or relevant work experience in the field did not have a significant impact on anticipated earnings since these are attributes that students already possess.

There are two institutional factors which also produce mixed effects on anticipated earnings. Engineering students expect to earn $6531 more than their counterparts in chemistry and physics. In addition, students who indicated that they had a mentor expect to earn $5954 less. This may reflect the type of career path that the mentoring relationship may reveal. Perhaps students who have mentors in the academy and may themselves wish to enter the academy, may have heightened expectations of salaries linked to faculty positions.

Two demographic variables, foreign status and marital status, and one background measure, mother's occupational status, were significant predictors of expected annual earnings. Students who are married expect to earn $3787 more than their non-married counterparts. However, international students expect to earn considerably less (-$6624) than their U.S. counterparts, perhaps reflecting different salary expectations based on home country comparisons. Finally, students whose mothers are scientists or engineers expect to earn $8563 less. It may be that these students may have more realistic expectations about the salaries that are commanded by graduate-level workers in these fields because they have first-hand knowledge about these kinds of careers from their mothers.

---Table 8 about here---

Expectations about finding a job in field. The most significant predictor of job expectations is the perception of race as a liability. Students who perceive of their race as a liability have 85% lower odds of expecting to find a job in their field. As we have developed this discussion in the paper, this seems to be an attitude of perceived disadvantage primarily expressed by Anglo men. In the current context of economic insecurity, these men may feel particularly insecure. As was the case with expected earnings, these negative expectations about racial status may be tempered by positive expectations about faculty/student relations. Each additional point increase in the faculty/student interaction rating accounts for a 5% increase in the odds of expecting to find a job in the chosen field.

Two other factors are associated with heightened job expectations: self-ratings of undergraduate preparation and academic ability. As anticipated, students who feel well prepared for graduate studies have 2 times greater odds of expecting to find a job in their field. Further, students

with higher academic self-confidence ratings are more likely to expect to find jobs. Each additional point increase in the self-confidence rating accounts for a 2% increase in the odds of expecting to find a job in the chosen field.

Of interest, one demographic measure, foreign status, and two institutional factors, belonging to a research group and student concerns about funding, have strong negative associations with job expectations. International students have 53% lower odds of expecting to find a job in their chosen field, perhaps reflecting the constraints to their employment both in their home countries as well as the United States. Also consistent to what was anticipated, students who express worry about their funding have 50% lower odds of expecting to find a job in the field. Again, this may reflect a heightened sensibility to the constraints that students may encounter. Students in more precarious financial situations may expect to make hard choices regarding job opportunities and may be less able to wait for the "ideal" job. The relationship between participation in a research group and job expectations was not anticipated. Previous studies would suggest that applied lab experience would make one better prepared for finding related employment upon graduation. However, this experience may also dampen student enthusiasm for like positions after graduation or perhaps broaden the vision of jobs that are available.

SUMMARY AND CONCLUSIONS

At time of entry, gender and racial differences in credentials, expectations about their graduate departments, and initial incorporation within graduate departments are generally insignificant for first-year students in engineering and the physical sciences. This is consistent with previous findings reported by Berg and Ferber (1983), Hackett et al.(1992) and the National Science Foundation (1994). Further, our multivariate results suggest that gender and minority status are insignificant factors in predicting the anticipated academic and career outcomes of first-year students. The only significant status characteristics predicting anticipated academic and career outcomes were foreign status and marital status. International students expected higher grades but anticipated lower earnings and more difficulty finding jobs in their field of study than their U.S. counterparts. Given the highly selective

nature of international student admissions to graduate school, international students may feel more confident about their academic abilities and subsequent performance. However, their anticipated career outcomes may be dampened by a greater sensibility regarding the range of opportunities and incomes available to them either within their countries of origin or within the United States. Married students expect to finish 4 months earlier than their non-married counterparts and anticipate higher wages upon degree completion. This may suggest that married graduate students have more constraints on their time, hence the need to finish their degrees more quickly. Further, they may be more likely to expect to need higher payoffs for completion of their degree.

Of interest, the social origins of graduate students produce mixed affects in the models. Students whose fathers were scientists or engineers had higher degree aspirations and perhaps, because of these higher aspirations, expected longer times to degree. However, students whose fathers had college degrees expected to finish their degrees earlier. Conversely, students whose mothers were employed were less likely to expect to obtain doctoral degrees. Moreover, students whose mothers were scientists and engineers expected lower earnings upon completion of degree. In each of these cases, parental exposure to these fields as well as their own experiences in college may provide incoming graduate students with information about degree programs and employment opportunities in these fields that may temper student expectations.

As expected from past research (i.e., Felder et al. 1995) prior academic ability and work experience continue to play a significant role in determining student expectations. Students with higher levels of ability or higher perceptions of that ability expect higher grades in graduate school and expect to find jobs in their chosen fields upon completing their degrees. Students with master's degree expect to complete their degrees earlier. However, these measures were insignificant predictors of anticipated earnings.

Consistent with the findings of Nettles (1990) and Hurtado and Carter (1994), students that anticipate more positive interactions with faculty expect to do better in graduate school. They are more likely to aspire to obtain doctorates, expect higher earnings upon completion of the degree, and

expect to find a job in their chosen field. What may be critical for graduate student persistence is the degree to which students actually develop positive, working relationships with departmental faculty as well as their perceptions of these relationships.

What may have been the most surprising set of results revolve around the importance of student expectations about the perceived deleterious effects of gender and racial status on academic and career expectations. Students who hold negative perceptions about how race and gender affect their academic careers are more likely to expect poorer academic performance, longer times to degree, differences in earnings, and expect more difficulties in finding jobs in their chosen fields. For the most part, we are talking about the perceptions of Anglo men regarding the detrimental impact of these statuses on their careers. Although the fraction of men who hold these attitudes is less than 20% of all Anglo males, it is disconcerting to speculate how these attitudes may play out in the academic setting.

Our results also underscore the importance of institutional factors which shape academic and career expectations. As expected, there are significant differences across programs and departments which translate in different expectations about time to degree and degree aspirations. Further, there are some notable differences among engineering students who expect higher grades and salaries. Although the results are mixed, having and mentor or belonging to a research group positively affects degree aspirations although it lengthens anticipated time to degree, lowers expected earnings and lowers expectations about finding jobs in chosen field.

It would be remiss not to mention one major caveat with this analysis. Since this is a study based on one institution with highly selective admissions criteria for all departments and programs included in the analysis, our findings may not be representative of the experience of other first-year graduate students in engineering and the physical sciences. Nor for that matter, can we expect that these findings are generalizable to the larger graduate student population. However, these results may be suggestive of areas that warrant further investigation within graduate education.

While our findings support earlier research on the similarities in academic credentials across gender and racial lines, we do not find support at this time that gender and racial differentials noted at later periods in the graduate training process are linked to differences in aspirations. Nevertheless, it has been well documented that women and minority students at the graduate level do not fare as well as their Anglo male counterparts in terms of degree completion rates, time to degree and completion of doctoral degrees (e.g., Hollenshead et al. 1996, Widnall 1988). If it's not initial differentials in academic ability nor expectations, what produces these outcomes?

Our analysis suggests that other factors, presumably institutional, may account for differences that appear later on in graduate training. For example, although we did not find significant differences in student affiliations with research advisors, mentors, or with membership within research groups, we do not know at this point the extent to which these relationships vary for men and women, or for majority, minority, and international students. Previous studies on mentoring suggest that there is a considerable range of mentoring experiences that tend to favor Anglo males relative to women and minority students. We need to deepen our understanding of these relationships as they evolve during the graduate career. Continual follow-up on our questions about student/faculty interactions, relations with departmental staff and students, as well as detailed probing about the mentoring experience will be needed in order to better identify the nuances in these relationships that develop along gender and racial lines.

Further, the expectations reported here are not static. We need to examine how student expectations as well as performance vary over time. What is particularly warranted is a thorough assessment of graduate student progress at milestone points (i.e., completion of coursework, completion of qualifying exams, completion of degree, move to first job after graduation). Careful study of these transitions should enable us to more precisely pinpoint when gender and racial disparities in outcomes emerge.

Finally, the significant differences in perceptions about the role of gender and racial status in shaping academic outcomes may play a strong role in developing the academic environment within

traditionally male-dominated field. If, on the one hand, females perceive that their presence within these departments primarily reflects their status as women and if, on the other hand, majority males feel disadvantaged by the presence of women or minorities, the potential for heightened tension and adversarial relations is increased. More detailed quantitative as well as qualitative data which directly focuses on climate issues is warranted.

ENDNOTES

1. In this paper, the term Anglo refers to students who are of European ancestry and do not identify themselves to be of Latino origin.

2. If international women are included the proportion of female doctoral recipients is approximately 11%.

3. At present, the Graduate Experience Project will trace the academic and career experience of this cohort through the 1999-2000 academic year.

4. For the next five years, we will be administering an annual survey to students in this cohort to monitor their academic progress as well as career development. In addition, administrative data will be appended to the survey data for participating students. All respondents were informed of the longitudinal nature of this study and 99% consented to the use of administrative data for the project. Survey and administrative data will be supplemented with qualitative data garnered through individual and focus group interviews with students, faculty and staff.

5. Within the literature there is considerable rhetoric regarding the cumulative disadvantage experienced by individuals who possess multiple minority statuses (see Hollenshead et al. 1996, Malcom 1992). In preliminary analyses of these data, we incorporated several interaction terms to test for the combined effects of being both *female and minority or foreign*, hypothesizing that these women might experience double jeopardy. However, the results from these analyses reveal that at least for this highly selective group of women, the combined effects of gender and minority status or foreign status were insignificant predictors of anticipated academic and career outcomes. However, we acknowledge the possibility that these multiple statuses may be significant at different stages of graduate education or career development.

6. Other measures indicating student ratings of programs and interactions with students were also derived from the data. However, these measures were dropped from the final multivariate analyses because they were insignificant predictors of academic or career outcomes.

7. Several alternative measures for financial support, including receipt of graduate assistantships and fellowships were used in earlier analyses. However, these measures were found to be insignificant predictors of the academic and career outcomes examined in this study.

8. While there is a significant difference in GRE quantitative scores for men and women, we would emphasize that, on average, both men and women are performing above the 80th percentile.

9. While this may be quite reasonable for master's degree students, the average expected time to degree for Ph.D. students was not much longer and is overly optimistic.

10. The lower salary expectations of foreign students may reflect, in part, anticipated wages (converted to U.S. dollars) in their home countries. However, note that these differences in anticipated earnings are not statistically significant.

11. Models using the logs of GPA and time were estimated and similar patterns of results were obtained. However, for ease of interpretation of the findings, we present the metric forms of these measures.

12. Generally, when the antilog is greater than 1, it is interpreted as the percent increase in the odds (or number of times higher odds for values greater than 2) in Y given a change in X. When the antilog is less than 1, the interpretation reflects the percent reduction in the odds of Y occurring given a change in X. Note that the percent reduction is calculated by subtracting the antilog value from 1. Using examples from Table 5, we see that the odds of expecting to obtain a doctorate are 2 times higher for students with post-BA work experience. However, the odds of expecting to complete doctoral studies are 55% lower for students who had mothers who are employed.

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Table 1. Academic Characteristics of First Year Engineering and Physical Sciences Graduate Student Sample by Gender, Ethnicity, and Resident Status

	All Men	Anglo Men	Minority Men	Foreign Men	All Women	Anglo Women	Minority Women	Foreign Women
	X or %	X or %	X or %	X or %	X or %	X or %	X or %	X or %
Undergraduate/Post BA Preparation								
Undergraduate GPA (4.0 scale)	3.5	3.5	3.5	3.4	3.5	3.5	3.4	3.5
GRE Verbal Score	563.4	604.2*	525.5	525.7*	543.7	599.3*	497.1	478.3*
GRE Math Score	754.8*	750.1	736.0*	765.7*	719.9*	720.6*	690.0	730.6
GRE Analytical Score	689.1	714.5	670.5	663.2	669.6	707.0	632.9	625.6
Self-rating of undergraduate preparation	41.7	42.7	29.2	45.1	32.4	34.3	41.7	26.1
Holds MA degree	13.8	10.9	4.2	20.7	11.3	2.9	8.3	26.1
Post-BA work experience	56.0	60.0	45.8	53.7	62.0	54.3	66.7	60.9
Academic environment rating	44.9	45.6	46.8	43.4	46.3	46.1	46.8	46.4
Self-efficacy rating	15.3	15.0	15.8	15.4	14.8	15.0	16.6	13.3
Academic self-confidence rating	128.1	127.5	131.1	127.8	124.8	123.0	144.4	117.4
Student Expectations								
Student expectations re: faculty/student interactions	112.7	111.6	115.2	113.4	113.6	113.6	112.8	113.8
Student expectations re: department	41.0	40.9	41.3	41.0	40.9	40.1	42.5	41.0
Student expectations re: interactions with other students	57.5	57.0	57.0	58.1	58.1	57.7	56.8	59.4
Student perception of gender as an asset	1.8*	0.0*	4.2*	2.4	40.9*	60.0*	50.0*	8.7
Student perception of gender as a liability	8.3*	11.8*	12.5*	2.4	0.0*	0.0*	0.0*	0.0
Student perceptions of race as an asset	2.8	.9	17.4	1.2	5.6	0.0	33.3	0.0
Student perception of race as a liability	10.6*	11.8*	21.7*	6.1	0.0*	0.0*	0.0*	0.0
Institutional Incorporation								
Interaction with department rating	3.4	3.9*	4.1	2.5*	3.5	3.9	5.1	2.3
Has research advisor	27.1	30.9	12.5	26.8	26.8	17.1	25.0	39.1
Has mentor in 1995-96	8.7	12.7	4.2	4.9	11.3	8.6	25.0	8.7
Belongs to research group	31.7	34.5	16.7	31.7	28.2	22.9	25.0	34.8
Has graduate assistantship	38.1	46.4	16.7	34.2	38.0	37.1	25.0	43.5
Has graduate fellowship	29.4	30.0	50.0	22.0	39.4	42.9	58.3	26.1
Has funding concerns	57.3	48.2	62.5	67.1	56.3	62.9	41.7	56.5
n of cases	218	110	24	82	71	35	12	24

SOURCE: Derived by the authors using Fall 1995 Graduate Experience Project data. * Differences across groups are significant at the $p < .05$ level, Scheffe test, one-way ANOVA.

Table 2. **Estimated Coefficients from Logit Models Predicting the Odds of Having a Departmental Mentor and Belonging to a Research Group for First Year Graduate Students**

	Odds of Being in Group			Odds of Having a Mentor		
	B	S.E.	Antilog	B	S.E.	Antilog
Demographic Characteristics						
Gender of R	-.515	.470	.60	.096	.546	1.10
U.S. minority student	-.673	.695	.51	-.134	.730	.87
Foreign student	1.499**	.607	4.48	-.485	.653	.62
Employment status in 1995-96	2.104**	1.010	8.20	-1.173	1.474	.31
Off-campus employment	-.411	.942	.66	-6.229	17.326	.01
Undergraduate/Post BA Preparation						
Undergraduate GPA (4.0 scale)	.512	.700	1.67	-2.495***	.908	.08
Self-rating of undergraduate preparation	.078	.430	1.08	-.191	.528	.83
Holds MA degree	.349	.674	1.42	.035	.971	1.04
Post-BA work experience	.340	.393	1.40	.359	.454	1.43
Self-rating of academic ability	-.002	.010	.99	-.006	.013	.99
Had BA mentor	.022	.411	1.02	-.079	.505	.92
Student Expectations						
Student expectations re: faculty/student interactions	.074**	.036	1.08	.087*	.050	1.09
Institutional Factors						
Enrolled PhD Program	.529	.573	1.70	-1.842**	.874	.16
Enrolled in Engineering	1.974***	.708	7.20	-.813	1.022	.44
Has graduate assistantship	2.244**	.904	9.43	2.472*	1.382	11.85
Has graduate fellowship	3.225***	.888	25.14	.793	.912	2.21
Had interactions with mentor/advisor before Fall 1995	2.554***	.498	12.85	2.204***	.642	9.06
Time at U-M	1.643***	.444	5.17	-.149	.561	.86
Intercept	-18.508***	5.107		-3.481	6.092	
-2 log-likelihood	169.565			122.925		

SOURCE: Derived by the authors using Fall 1995 Graduate Experience Project data.
*** p <.01, ** p < .05, * p <.01.

Table 3. **Anticipated Academic and Career Outcomes of First Year Engineering and Physical Sciences Graduate Student Sample by Gender, Ethnicity, and Resident Status**

	All Men	Anglo Men	Minority Men	Foreign Man	All Women	Anglo Women	Minority Women	Foreign Women
	X or %	X or %	X or %	X or %	X or %	X or %	X or %	X or %
Anticipated Academic Outcomes								
Expected 95-96 GPA (4.0 scale)	3.8*	3.8	3.8	3.9*	3.7*	3.7*	3.7	3.9*
Highest degree aspirations - MA	25.7	30.9	45.8	13.4	31.0	37.1	25.0	21.7
Highest degree aspirations - Ph.D.	63.3	60.9	45.8	70.7	57.6	51.4	66.7	65.2
Time to degree (years)	3.0	3.2	2.8	2.9	3.0	2.9	2.8	3.2
Anticipated Career Outcomes								
Expected annual wages on completion of degree ($)	47252	50074	47227	43197	44373	45645	50000	37688
Expect to find a job in field of study	58.7	62.7	66.7	50.0	59.2	68.6	75.0	34.8
n of cases	218	110	24	82	71	35	12	24

SOURCE: Derived by the authors using Fall 1995 Graduate Experience Project data. * Differences across groups are significant at the $p < .05$ level, Scheffe test, one-way ANOVA.

Table 4. Hierarchical OLS Regression Models Predicting Expected First Year Academic Achievement (GPA)

	Model 1 (n=261)		Model 2 (n=261)		Model 3 (n=239)		Model 4 (n=236)		Model 5 (n=236)	
	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Demographic Characteristics										
Gender of R	-.087*	.046	-.077*	.046	-.068	.043	-.075*	.046	-.060	.044
Minority status	.033	.057	.038	.058	.050	.057	.076	.059	.073	.058
Foreign status	.233***	.042	.242***	.043	.246***	.043	.237***	.043	.262***	.044
Marital status	.089**	.043	.084*	.043	.070*	.042	.057	.043	.057	.042
Employment status in 1995-96	.035	.038	.029	.039	-.019	.038	-.033	.038	-.006	.039
Background Characteristics										
Mother has college degree			.018	.045	.003	.043	.009	.043	.006	.043
Father has college degree			.071	.054	.053	.051	.035	.051	.050	.051
Mother is scientist/engineer			-.001	.083	-.081	.084	-.089	.084	-.074	.082
Father is scientist/engineer			.092*	.051	.031	.049	.037	.049	.034	.049
Lower/working class status			.030	.055	.027	.052	.007	.052	.033	.052
Upper class status			-.084	.059	-.128**	.057	-.135**	.057	-.164***	.057
Mother is employed			.016	.046	.010	.043	.011	.043	.015	.042
Undergraduate/Post BA Preparation										
Undergraduate GPA (4.0 scale)					.222***	.060	.202***	.060	.211***	.059
Self-rating of undergraduate preparation					.082**	.039	.086**	.039	.065*	.039
Holds MA degree					.072	.054	.097*	.055	.100	.062
Post-BA work experience					.039	.034	-.031	.034	.017	.034
Self-rating of academic ability					.004***	.001	.004***	.001	.004***	.001
Student Expectations										
Student expectations re: faculty/student interactions							.004	.003	.004	.003
Student perception of gender as liability							.192*	.101	.156	.100
Student perception of race as liability							-.207**	.093	-.182**	.091
Institutional Factors										
Type of degree									-.001	.026
Program									.172***	.063
Has mentor in 1995-96									-.038	.059
Belongs to research group									.020	.043
R has funding concerns									-.059	.038
Intercept	3.699***	.038	3.612***	.060	2.368***	.229	2.076***	.374	1.908***	.385
Adjusted R^2	.120		.134		.298		.310		.341	
F	8.067***		4.350***		6.948***		6.282***		5.866***	

SOURCE: Derived by authors from Fall 1995 Graduate Experience Project data. *** p < .01, ** p < .05, * p < .10.

Table 5. Estimated Coefficients of Hierarchical Logit Models Predicting Degree Aspirations of First Year Graduate Students in Engineering and the Physical Sciences

	Model 1 (*n* = 289)		Model 2 (*n* = 289)		Model 3 (*n* = 258)		Model 4 (*n* = 254)		Model 5 (*n* = 254)	
	B	Antilog	B	Antilog	B	Antilog	B	Antilog	B	Antilog
Demographic Characteristics										
Gender of R	-.15	.86	-.15	.86	-.15	.86	-.27	.76	-.20	.82
Minority status	-.21	.81	-.32	.73	-.48	.62	-.44	.64	-.22	.80
Foreign status	.50*	1.64	.52*	1.68	.59*	1.80	.40	1.50	.58	1.78
Marital status	-.18	.84	-.30	.74	-.41	.66	-.46	.63	-.48	.62
Employment status in 1995-96	.53**	1.71	.51*	1.66	.60**	1.82	.52*	1.67	.29	1.34
Background Characteristics										
Mother has college degree			.01	1.01	.34	1.41	.32	1.38	.52	1.68
Father has college degree			-.18	.83	-.04	.96	-.18	.84	-.60	.55
Mother is scientist/engineer			.18	1.19	.55	1.74	.35	1.42	.70	2.01
Father is scientist/engineer			1.03***	2.79	1.03**	2.81	1.11***	3.04	1.20**	3.31
Lower/working class status			.65*	1.91	.81*	2.24	.67	1.95	.59	1.81
Upper class status			-.15	.86	-.36	.70	-.39	.68	-.02	.98
Mother is employed			-.23	.79	-.39	.67	-.44	.64	-.80**	.45
Undergraduate/Post BA Preparation										
Undergraduate GPA (4.0 scale)					.76	2.14	.59	1.81	.22	1.24
Self-rating of undergraduate preparation					-.76**	.47	-.75**	.47	-.77**	.46
Holds MA degree					.84*	2.33	1.16**	3.18	.72	.49
Post BA work experience					.60**	1.83	.73**	2.08	.70**	2.02
Self-rating of academic ability					.00	1.00	-.00	1.00	-.00	1.00
Student Expectations										
Student expectations re: faculty/student interactions							.08***	1.08	.07**	1.08
Student perception of gender as liability							1.04	2.83	1.18	3.26
Student perception of race as liability							-1.23	.29	-1.52	.22
Institutional Factors										
Type of degree									1.42***	4.13
Program									.91	2.50
Has mentor in 1995-96									.29	1.34
Belongs to research group									.94***	2.56
R has funding concerns									.18	1.20
									(.34)	
Intercept	.17		.18		-3.05		-10.85***		-12.53***	
-2 log likelihood	374.45		360.82		300.93		284.49		244.47	

SOURCE: Derived by authors from Fall 1995 Graduate Experience Project data. *** $p < .01$, ** $p < .05$, * $p < .10$.

Table 6. Hierarchical OLS Regression Models Predicting Anticipated Time to Degree of First Year Graduate Students in Engineering and the Physical Sciences

	Model 1 (n = 261)		Model 2 (n = 261)		Model 3 (n = 239)		Model 4 (n = 236)		Model 5 (n = 236)	
	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Demographic Characteristics										
Gender of R	-.121	.235	-.008	.233	-.105	.237	-.105	.247	-.073	.186
Minority status	-.269	.296	-.272	.295	-.143	.310	-.164	.324	.113	.243
Foreign status	-.071	.217	.011	.219	.002	.234	-.005	.239	.064	.186
Marital status	-.177	.223	-.279	.221	-.294	.231	-.288	.236	-.391**	.177
Employment status in 1995-96	.502***	.196	.392**	.197	.390*	.207	.382*	.211	.031	.165
Background Characteristics										
Mother has college degree			-.059	.230	-.059	.236	-.071	.241	.102	.181
Father has college degree			-.038	.273	.081	.276	.046	.283	-.359*	.215
Mother is scientist/engineer			-.066	.421	-.119	.459	-.122	.465	.058	.348
Father is scientist/engineer			.817***	.259	.525*	.269	.551**	.273	.557***	.208
Lower/working class status			.178	.279	.038	.283	-.035	.290	-.268	.218
Upper class status			-.550*	.299	-.495	.314	-.486	.319	-.020	.242
Mother is employed			.246	.231	.412*	.236	.407*	.238	.184	.179
Undergraduate/Post BA Preparation										
Undergraduate GPA (4.0 scale)					1.100***	.328	1.046***	.333	.666***	.251
Self-rating of undergraduate preparation					-.347	.213	-.366*	.217	-.144	.165
Holds MA degree					.890***	.293	.890***	.304	-.446*	.261
Post-BA work experience					.180	.184	.181	.188	.132	.143
Self-rating of academic ability					-.003	.005	-.004	.005	-.003	.004
Student Expectations										
Student expectations re: faculty/student interactions							.014	.016	.004	.012
Student perception of gender as liability							.619	.563	.737*	.422
Student perception of race as liability							-.257	.514	-.598	.385
Institutional Factors										
Type of degree									.999***	.108
Program									-.787***	.265
Has mentor in 1995-96									.491**	.249
Belongs to research group							--		.194	.183
R has funding concerns									.004	.162
Intercept	2.864***	.196	2.646***	.305	-.948	1.254	-2.286	2.074	-1.418	1.625
Adjusted R^2	.017		.063		.129		.124		.514	
F	1.893*		2.447***		3.078***		2.662***		10.957***	

SOURCE: Derived by authors from Fall 1995 Graduate Experience Project data. *** p < .01, ** p < .05, * p < .10.

Table 7. Hierarchical OLS Regression Models Predicting Expected Annual Earnings on Completion of Graduate Training

	Model 1 (n = 261)		Model 2 (n = 261)		Model 3 (n = 239)		Model 4 (n = 236)		Model 5 (n = 236)	
	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Demographic Characteristics										
Gender of R	-2682.0	2216.0	-3324.0	2240.0	3932.0*	2259.0	-4293.0*	2310.0	-3504.0	2310.0
Minority status	-741.0	2790.0	-292.0	2832.0	451.0	2947.0	-1809.0	3036.0	-1287.0	3021.0
Foreign status	-6542.0***	2048.0	-6525.0***	2107.0	-6667.0***	2228.0	-7325.0***	2237.0	-6624.0***	2309.0
Marital status	2805.0	2101.0	3786.0*	2119.0	3160.0	2194.0	4110.0*	2214.0	3787.0*	2203.0
Employment status in 1995-96	2153.0	1850.0	2576.0	1894.0	1606.0	1969.0	1863.0	1979.0	2566.0	2055.0
Background Characteristics										
Mother has college degree			444.0	2208.0	1193.0	2243.0	-1934.0	2252.0	-2074.0	2252.0
Father has college degree			2214.0	2621.0	3505.0	2628.0	3455.0	2653.0	3978.0	2678.0
Mother is scientist/engineer			-5171.0	4042.0	8692.0**	4362.0	-9549.0**	4352.0	-8563.0**	4331.0
Father is scientist/engineer			-206.0	2488.0	885.0	2561.0	-1053.0	2558.0	-2201.0	2589.0
Lower/working class status			-1774.0	2679.0	-2337.0	2689.0	-2460.0	2711.0	-1857.0	2713.0
Upper class status			5379.0*	2868.0	4585.0	2983.0	4843.0	2981.0	4238.0	3006.0
Mother is employed			283.0	2227.0	1222.0	2240.0	1008.0	2231.0	941.0	2225.0
Undergraduate/Post BA Preparation										
Undergraduate GPA (4.0 scale)					2185.0	3119.0	2245.0	3120.0	1781.0	3120.0
Self-rating of undergraduate preparation					728.0	2026.0	793.0	2035.0	583.0	2058.0
Holds MA degree					3426.0	2788.0	2610.0	2843.0	41.0	3251.0
Post-BA work experience					887.0	1750.0	844.0	1760.0	1195.0	1774.0
Self-rating of academic ability					91.0**	46.0	80.0*	47.0	71.0	47.0
Student Expectations										
Student expectations re: faculty/student interactions							363.0**	151.0	381.0**	152.0
Student perception of gender as liability							-7532.0	5266.0	-9211.0*	5251.0
Student perception of race as liability							8061.0*	4808.0	8955.0*	4787.0
Institutional Factors										
Type of degree									2117.0	1342.0
Program									6531.0**	3302.0
Has mentor in 1995-96									-5954.0*	3092.0
Belongs to research group									519.0	2278.0
R has funding concerns									-1601.0	2011.0
Intercept	47802.0***	1845.0	45477.0***	2932.0	25606.0	11925.0	-13270.0	19413.0	-22994.0	20211.0
Adjusted R^2	.04		.05		.09		.11		.13	
F	3.27***		2.22**		2.32***		2.42***		2.36***	

SOURCE: Derived by authors from Fall 1995 Graduate Experience Project data. *** p <.01, ** p <.05, * p<.10.

Table 8. Estimated Coefficients of Hierarchical Logit Models Predicting First Year Graduate Students' Expectations of Finding a Job in Field on Completion of Degree

	Model 1 (n = 289)		Model 2 (n = 289)		Model 3 (n = 254)		Model 4 (n = 254)		Model 5 (n = 254)	
	B	Antilog	B	Antilog	B	Antilog	B	Antilog	B	Antilog
Demographic Characteristics										
Gender of R	.07	.93	.18	.83	-.01	.99	-.14	.87	-.08	.92
Minority status	.27	1.31	.25	1.29	.08	1.09	.04	1.05	.02	1.03
Foreign status	.80***	.45	-.96***	.38	-.84**	.43	-.93***	.39	-.75**	.47
Marital status	-.13	.88	-.06	.94	-.09	.91	-.10	.90	-.18	.83
Employment status in 1995-96	-.37	.69	-.29	.75	-.49	.61	-.53*	.59	-.24	.79
Background Characteristics										
Mother has college degree			.04	1.04	-.12	.89	-.07	.93	-.08	.93
Father has college degree			.44	1.55	.56	1.74	.49	1.64	.58	1.79
Mother is scientist/engineer			.99*	2.69	.32	1.38	.22	1.25	.31	1.36
Father is scientist/engineer			-.77*	.46	-.62*	.54	-.58	.56	-.56	.57
Lower/working class status			.08	1.08	.36	1.43	.34	1.40	.49	1.62
Upper class status			.75*	2.12*	.45	1.57	.46	1.59	.22	1.25
Mother is employed			.18	1.20	-.08	.93	-.04	.96	.02	1.02
Undergraduate/Post BA Preparation										
Undergraduate GPA (4.0 scale)					-.82*	.44	-.90*	.41	-.82	.44
Self rating of undergraduate preparation					.82***	2.27	.80**	2.23	.72**	2.06
Holds MA degree					-.97**	.38	-.92**	.40	-.67	.51
Post BA work experience					.18	1.19	.25	1.28	.42	1.53
Self rating of academic ability					.02***	1.02	.02**	1.02	.02**	1.02
Student Expectations										
Student expectations re: faculty/student interactions							.03	1.03	.05*	1.05
Student perception of gender as liability							1.16	3.18	.95	2.58
Student perception of race as liability							-1.86*	.16	-1.92*	.15
Institutional Factors										
Type of degree									.01	1.01
Program									.82	2.26
Has mentor in 1995-96									-.01	.99
Belongs to research group									-.85**	.43
R has funding concerns									-.70**	.50
Intercept	.86*		.45		.62		-2.59		-4.64	
-2 log-likelihood	378.75		364.82		305.08		294.96		283.77	

SOURCE: Derived by authors from Fall 1995 Graduate Experience Project data. *** p<.01, ** p<.05, * p<.10

Appendix A. Comparison Statistics for Fall 1995 Cohort and Sample Respondents

Selected Characteristics	Fall 1995 Cohort	Sample Respondents
Total	589	289
Percent female students	19.9	25.0
Percent international students	41.0	36.0
Percent in Engineering	88.5	83.0
Percent in Ph.D. programs	29.5	31.1
GRE Math score	743	740
Undergraduate GPA	3.5	3.5
Response Rates		
Overall response rate (%)		49.1
Response rate - males (%)		46.2
Response rate - females (%)		60.1
Response rate - U.S. students (%)		53.8
Response rate - international students (%)		43.4
Response rate - Engineering (%)		47.4
Response rate - Physical Sciences (%)		61.8
Response rate - in M.S. programs (%)		48.3
Response rate - Ph.D. programs (%)		52.3

SOURCE: Derived from Fall 1995 Graduate Experience Project data and data extract provided by The School of Graduate Studies.